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HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION

1922

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Issued July, 1924

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1924

HAWAII AGRICULTURAL EXPERIMENT STATION, HONOLULU.

[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture.]

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Washington, D. C. July 11, 1924

REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION, 1922.

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SUMMARY OF INVESTIGATIONS.

By J. M. WESTGATE, *Agronomist in Charge.*

During the fiscal year 1922 the station continued to emphasize the necessity of furthering the diversified agricultural industries of the islands by promoting the production of many new and improved forage crops, fruits, and vegetables and by working out rational cropping systems suitable to sugar cane and pineapple growing.

Introducing such new plants as are believed to be of economic value and improving many of the useful fruits now under cultivation in the Territory by breeding and selection work has constituted a major project of the horticultural division. The best of these will be propagated and distributed to growers throughout the Territory. During the year, 232 different varieties were received and 22,100 plants of improved and promising strains distributed.

Agronomic investigations were carried on with root, green-manuring, grain, and forage crops, and also with aquatic crops of economic importance and oriental origin. To meet the needs of those combining poultry raising with vegetable gardening, the agronomist devoted part of his time to poultry work, introducing breeding stock of high egg-producing capacity, and conducting caponizing and culling demonstrations.

In the chemical division investigations were conducted to determine the most profitable utilization of surplus fruits which are prevented by quarantine regulations from being exported. The dehydration of certain fruits and vegetables and the making of jams, jellies, and preserves promises to become of commercial importance.

The resignation of the superintendent of extension on November 1, 1921, necessitated considerable readjustment of the various activities of the station and the assignment of certain phases of the department to other workers, pending the filling of the vacancy.

Many of the projects of the Haiku substation were brought to a satisfactory close and others were transferred to the Haleakala substation and demonstration farm for continuation. A few of the projects are being carried on in connection with the station by the new manager of the farm on which the Haiku substation was located.

The extension agent for the Island of Hawaii devoted the major part of his time to orchard work and to the improvement of pastures on the various cattle ranches. During the year he traveled 11,200 miles, mostly by automobile, and visited 1,500 farmers, in addition to distributing bulletins, vegetable and fruit seed, young nursery stock, and cuttings and suckers to homesteaders, ranchmen, and plantation managers. Much assistance was given in ordering varieties of seed, in selecting seed in the field, and in applying the right amount of fertilizer to the different soils of the various localities.

Home demonstration work was continued on practically the same scale as last year, the home economics demonstrator again working part time as collaborator and operating through various local organizations, assuring large interested audiences.

The station made a representative exhibit of various phases of its work at the fourth annual Maui County Agricultural Fair, which was held from October 15 to 23, inclusive, and several members of the staff acted as judges on a number of the important fair committees.

REPORT OF THE HORTICULTURAL DIVISION.

By W. T. Pope.

MISCELLANEOUS FRUIT INVESTIGATIONS.

BANANAS.

Renewed activity in banana growing is very apparent, and in many places small plantations are starting. No large corporations have as yet entered the industry. Approximately 18,000 bunches per month were shipped to the markets of the mainland during the year, and prices fluctuated considerably, the net wholesale price per pound f. o. b. Honolulu wharf ranging from $0.027 in July and August, to $0.043 in January and February. The price of offshoots of the Chinese banana ranged from $15 to $20 per hundred, and Bluefields, which are rarely available, were even higher. Brazilian and Ice Cream sold for $5 to $10 per hundred.

The station is growing 26 different varieties of bananas in a sheltered valley at the Tantalus substation and plans to select promising varieties from this collection for determination as to their commercial possibilities. Kona Maiamaoli, an excellent banana which has been grown for generations in the Kona district is thought to have a great commercial future. (Pl. I, fig. 1, and Pl. II, fig. 1.) The Chinese variety is considered most desirable of all for planting in the lower elevations and in gardens, being a low-growing plant which produces large fruit early in the season. Offshoots from a small planting at the central station were distributed during the year to school and home gardens. Bluefields is a good shipper, but the plant is tall growing and should be planted in localities that are relatively free from strong winds. Brazilian and Ice Cream withstand considerable wind, but are grown for local consumption only. Popoulu Kaio is an excellent native variety. (Pl. I, fig. 2, and Pl. II, fig. 2.) The native varieties, which are classed chiefly as cooking bananas, are raised for local use only.

PAPAYAS.

The papaya is more in demand than ever in Hawaii and brings such high prices on the market that most dealers retail their fruit by the pound.

The papaya investigations, which were begun by the station about two years ago, are already showing interesting results. Seedlings of the Solo variety, which is composed of several strains each differing in shape of fruit, have just come into bearing, producing fruit of superior form and quality to that of the parent. (Pls. III and IV.) The trees conform to the ideal in that they have short, stout trunks and begin early to bear an abundance of fruit. In many instances, 11-months old trees support a weight of 40 to 70 pounds.

It is quite evident that papayas of very high quality can be produced by proper methods and that the nature of the flesh of the fruit changed by direct cross-pollination, just as is the case with the seed. It is hoped that the monœcious type can be developed to such an extent that choice characters will not be frequently changed by cross-pollination.

Grafting methods were not satisfactory to any great extent in the production of standard fruit, but when lateral branches were planted as cuttings the fruits produced equaled those of the parent tree in quality. The terminal growth may be removed from 2-year old trees which bear their fruit too high to permit of convenient picking. This will cause lateral buds to sprout from some of the leaf scars along the trunk. When these laterals attain a length of 1½ or 2 feet they can be removed and set 8 or 10 inches deep in coarse gravelly soil. Given careful attention, they will soon root and develop as new trees, producing fruit of excellent quality. Some trees produce only few laterals, while others develop 25 or even 50.

Papayas of very fine quality may be produced from selected seed for general purposes provided they are given good culture. The seedlings should be planted 8 feet apart each way in rows in rich soil with good drainage. The soil about the plants should be enriched with thoroughly decomposed barnyard manure at the time of planting, and the young trees given clean culture and plenty of water if a large yield of well-flavored fruit is to be expected.

During the year seed of the Dapitan papaya germinated, and the young seedlings were set in a trial plat. This variety was received from the Philippine Islands.

CITRUS FRUIT.

The citrus orchard, which now contains 160 trees representing 35 different varieties, is located on the southeastern slope of Punchbowl Mountain where the soil is of tufa lava origin. This orchard was fertilized with barnyard manure and given thorough cultivation during the spring, summer, and fall months. Early in November it was sown with mungo beans (*Phaseolus mungo*), 150 pounds of seed being broadcasted per acre, and in April the cover crop was turned under. The treatment greatly improved the soil, and the Kusaie lime and several varieties of orange and lemon trees bore heavy crops of fruit as a result.

After making an extended survey of the orange trees growing in the district of Kona, the horticulturist has succeeded in obtaining bud wood from what is thought to be the best Hawaiian (Polynesian) orange tree for budding on seedling stocks of sour orange and rough lemon trees growing at the central station. The tree is vigorous and prolific and produces large, smooth-skinned, sweet, juicy fruit containing few seeds. Several consignments of the bud wood have been propagated for distribution. Cooperative experiments are being carried on with W. D. Ackerman and W. H. Greenwell, who have set out an acre of these selected budded trees in Kona.

About 50 sweet shaddock trees have been propagated from a tree producing fruit of very fine quality. The original tree is owned by Mr. and Mrs. Henry A. Gehring, Honolulu, who kindly permitted the removal of graftwood that this choice fruit might be made available to others.

AVOCADOS.

Of the 40 budded varieties of avocado trees in the orchard at the Tantalus substation, 14 are of the Popenoe Guatemalan collection. These trees are growing without irrigation at an elevation of 1,000 feet. Some are now past their third year, six have blossomed, and two are setting fruit. Bud wood of the varieties Northrup, Taft, Solano, Puebla, Harmon, Fuerte, and Trapp, which are in common cultivation in California, has been received and successfully propagated. Fully 85 varieties are now under trial at the station, and 5 cooperative experiments with private owners are being carried on.

An effort is being made to group varieties fruiting at different seasons, so that the fruit may be in season throughout the year instead of being confined practically to the summer months. In the Kona district some trees of the West Indian type ripen their fruit during the winter months, while on Oahu the trees usually ripen their fruit in the summer. Among those producing fruit in the fall, winter, and spring are Beardslee (Ables), Macdonald (Pl. V, fig. 1), Nutmeg, Kalua, Wilder, Kinau, and the Case avocado (Pl. VI, fig. 1), all of which have considerable local reputation for quality.

During the year the station propagated over 800 seedlings for use as rootstocks in further experimental propagation work.

One of the important observations noted in connection with avocado growing is the frequency with which seedlings, the progeny of good varieties, develop fruit of good quality. In many instances the fruit is superior to that of the parent.

MANGOES.

Ninety trees of various varieties of mango are under trial, the most promising of which are being propagated for distribution. The least desirable trees have been removed to give space to the remainder and to permit of the cultivation of the orchard. Pruning and culti-

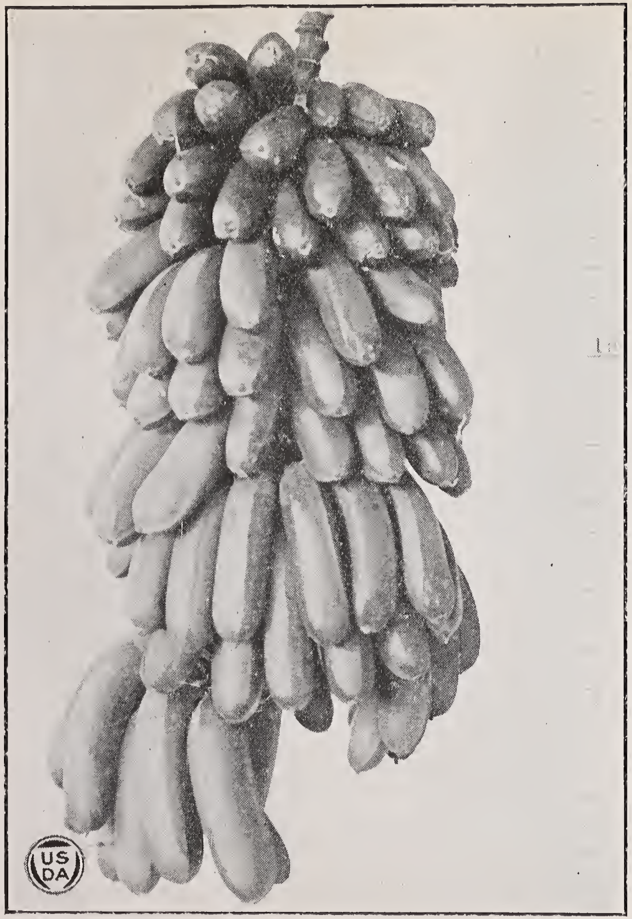

FIG. 1.—BANANA, NATIVE VARIETY KONA MAIAMAOLI. ONE OF THE BEST HAWAIIAN COOKING BANANAS.

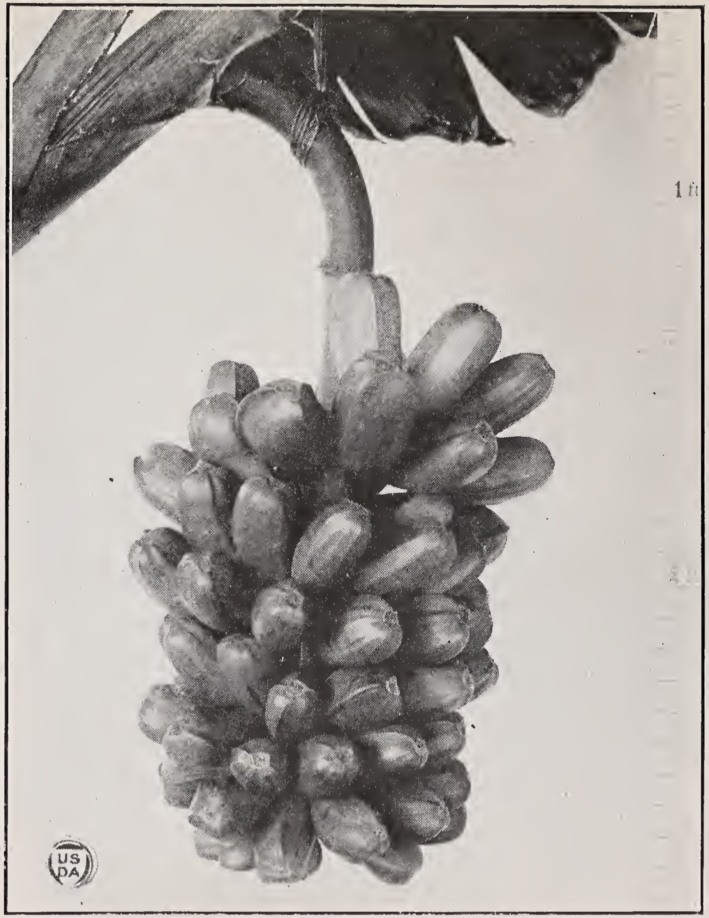

FIG. 2.—BANANA, NATIVE VARIETY POPOULU KAIO. BUNCH MEDIUM SIZE; AVERAGE WEIGHT, 30 POUNDS. USED AS FRESH FRUIT OR COOKED.

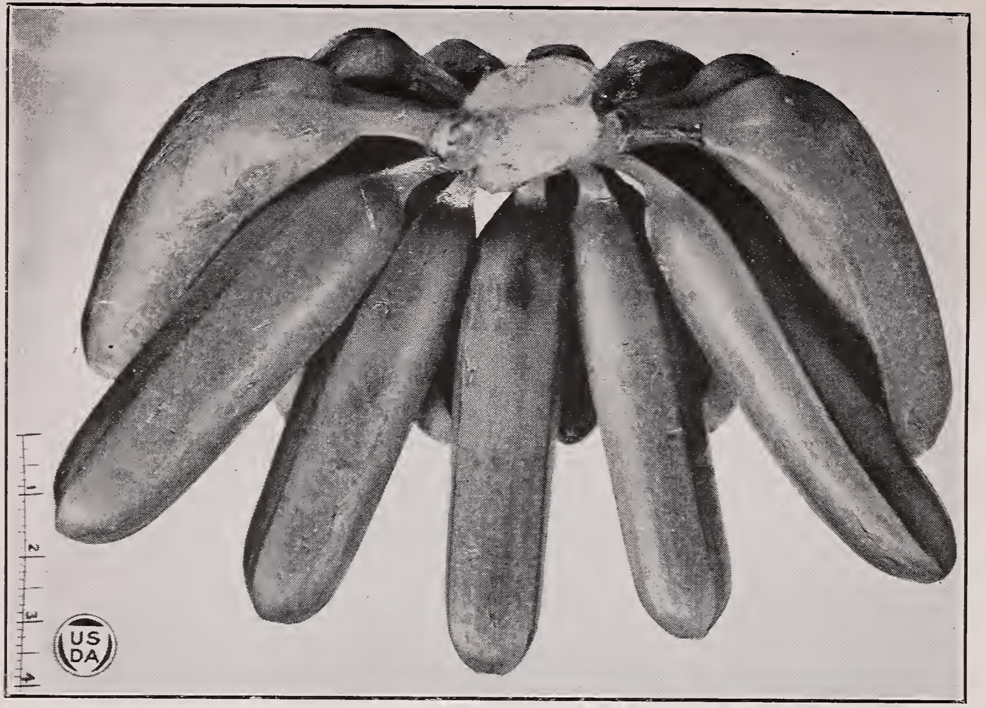

FIG. 1.—HAND OF KONA MAIAMAOLI BANANAS.

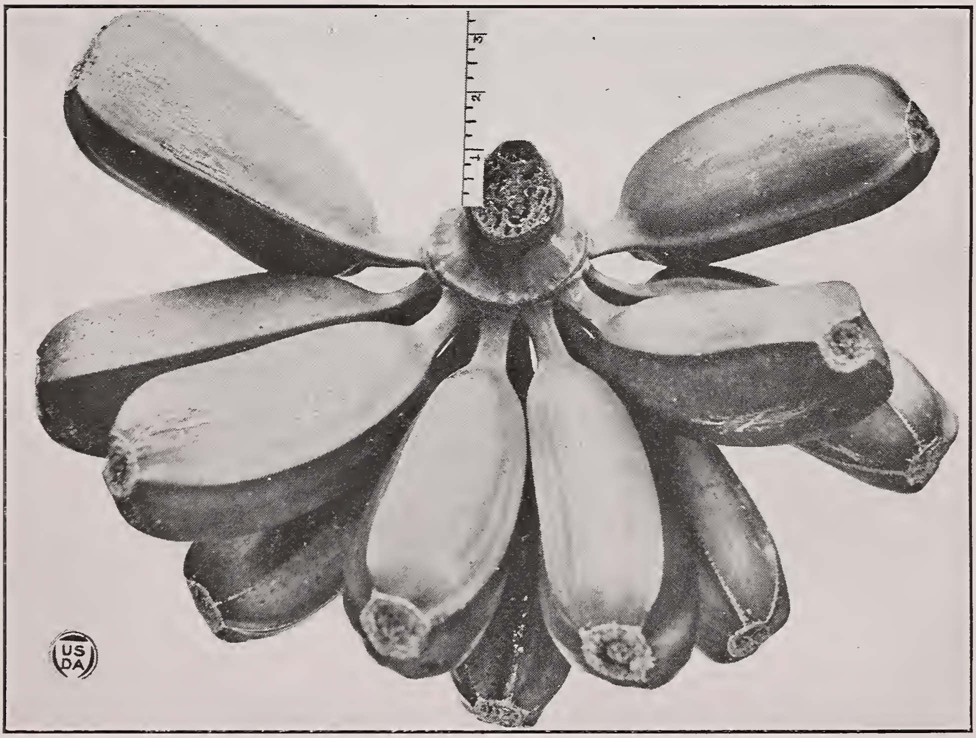

FIG. 2.—HAND OF POPOULU KAIO BANANAS.

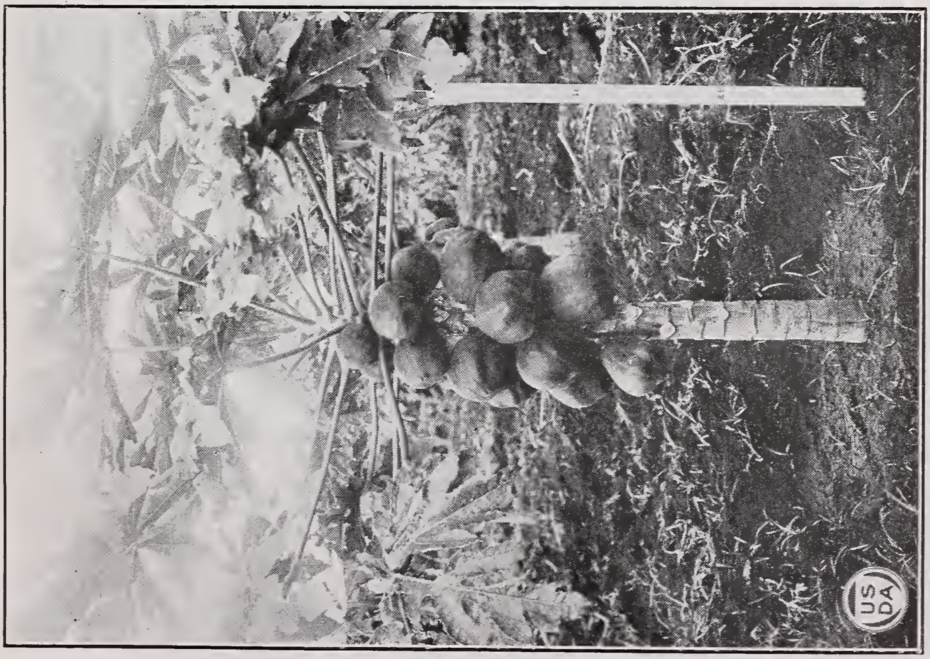

FIG. 1.—PAPAYA NO. 4610. ROUND TYPE.

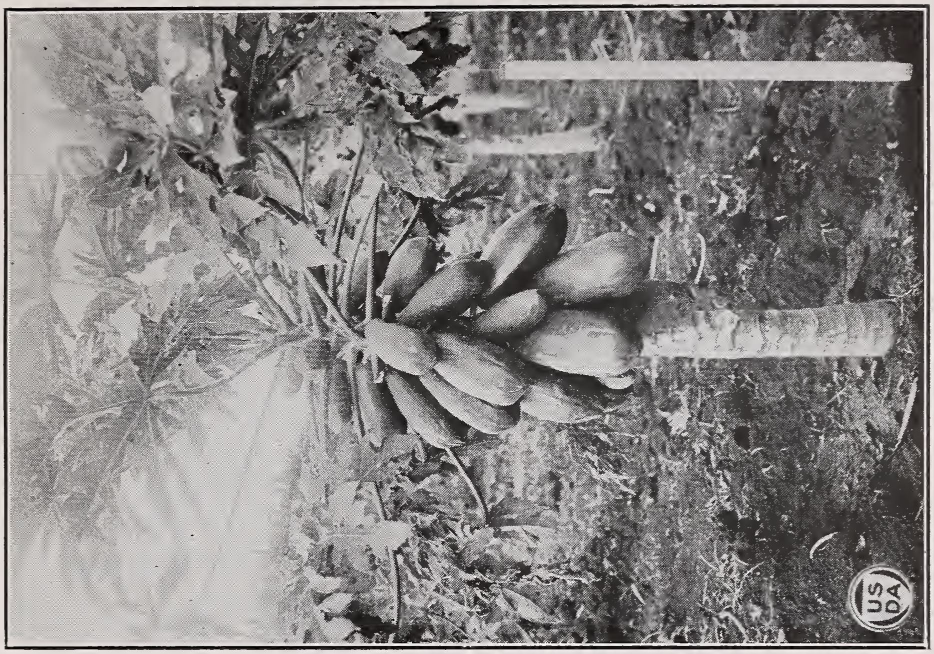

FIG. 2.—PAPAYA NO. 4618. LONG TYPE.

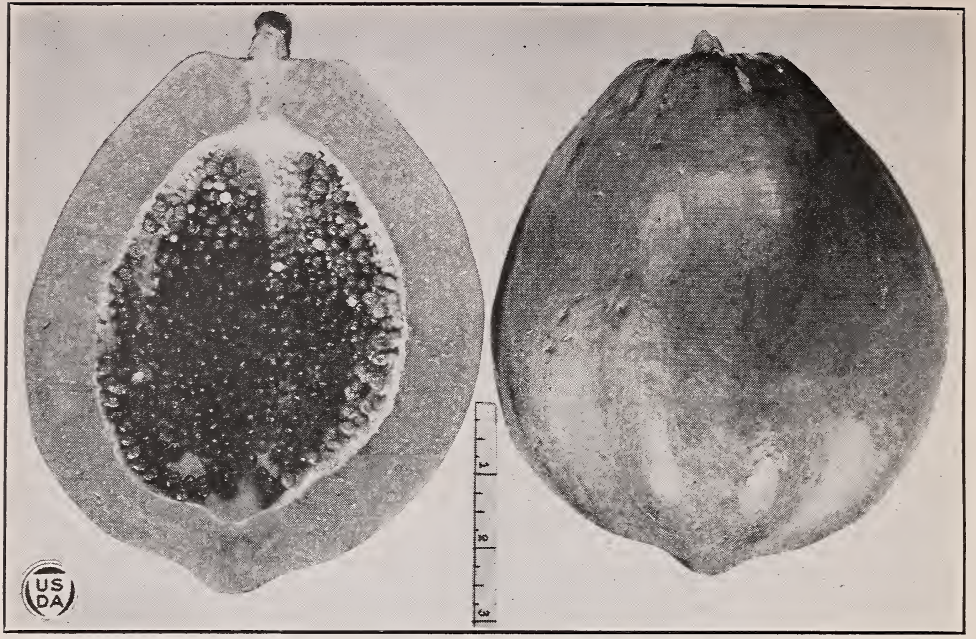

FIG. 1.—PAPAYA NO. 4610. FRUIT WEIGHS 4 POUNDS. COLOR, BRIGHT YELLOW.

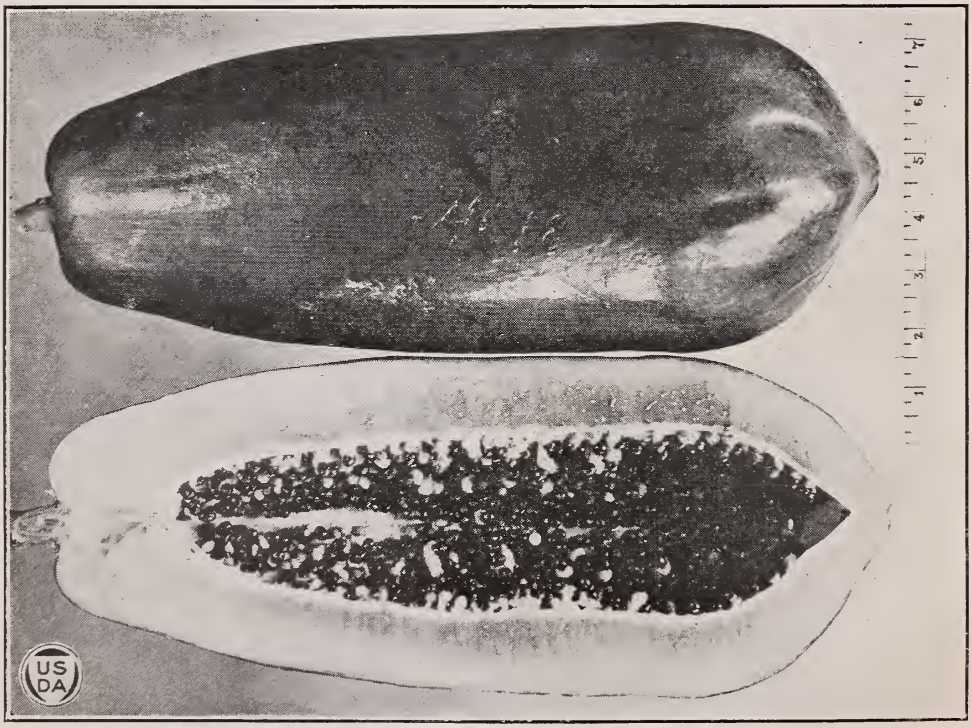

FIG. 2.—PAPAYA NO. 4618. FRUIT WEIGHS 6½ POUNDS. COLOR, YELLOW.

vation have helped to improve both yield and quality of the fruit and to reduce the ravages wrought by the mango weevil (*Cryptorhynchus mangiferæ*. Experiments show that the Pirie can be propagated by the bark-graft method, several hundred 1-year old seedlings having been successfully grafted with scions of this variety. Fourteen hundred seedling mangoes are being grown for grafting and budding to a number of good varieties which as yet are hardly known in the Territory. Local varieties springing from West Indian stock seem to do better and to be more prolific than Indian varieties, many of which are shy bearers and often fail to produce for several years in succession.

Victoria.—Among the seedlings developed from seed introduced into the islands from the West Indies during the 80's was a mango known as No. 9. Seed of this tree was planted on the date of the diamond jubilee of the late Queen Victoria of England, and the resulting tree was called Victoria. (Pl. VI, fig 2.) The tree is very prolific, producing sometimes as many as three crops a year. The fruits are usually produced singly on individual stems and differ in color from any other variety of mango growing in Hawaii, being red from the time they set and becoming brilliant scarlet on ripening. Like some other mangoes, the Victoria reproduces its quality of fruit fairly true to type on seedling trees. This variety may be propagated by grafting.

The fruit is of medium size, weighing about 9 ounces. Form, oblong, slightly **S** shaped, and at stem end somewhat necked; apex, broadly rounded with curve ending in a small blunt beak sometimes containing small hole-like depressions; color when ripe, brilliant vermilion shaded over yellow background, especially at the apex; surface, marked with small yellow dots, which become overcast where red is deepest; shoulder of fruit has delicate powdery bloom; skin, of medium thickness and peels off well; aroma, pleasant; ripe flesh, deep rich, yellow color and good texture; juice, sweet, acid, and of flavor of Pirie mango; seed, small, weighing three-quarters ounce; marketing qualities ranking among best varieties in Hawaii.

Wootten.—The Wootten is one of half a dozen trees which were inarched from the original tree growing in the yard of H. Wootten, on Makiki Street, Honolulu. Even before it is fully ripe, this variety has a beautiful coloring which is a very desirable marketing feature. In moderate temperatures the ripe fruit will remain in good condition for two weeks.

The fruit is medium to large; form, roundish, slightly flattened on the sides (no apex point evident); weight, about 10 ounces; color when ripe, a shade between orange yellow and yellow orange with tinges of pink and red at the stem end and pale yellow dots scattered over the surface; skin, medium thin, tough, and with fair peeling qualities; aroma, very pleasant; flesh, rich apricot yellow of very good texture; flavor, excellent; juice, sweet, acid; seed, medium to small for size of fruit.

Kalihi.—This hybrid is thought to be the result of a cross between a West Indian variety known as No. 5 and some other West Indian mango which grew in the Government nursery grounds on King Street, Honolulu. The trees are vigorous and prolific and produce fruit of fine quality when given cultivation.

The fruit is of medium size (Pl. V, fig. 2), weighing 11 ounces; form, oval with broad stem-end, which is depressed like that of the apple; apex end, broad, terminating in two rounded points, one of which is more prominent than the other; when ripe, the color is golden apricot splashed over the shoulders with blood-red spots and dotted over the whole surface with light yellow; skin, medium thickness, rather tough, peels off well; aroma, pleasant; ripe flesh, deep, rich yellow, of good texture; juice, sweet with subacid flavor; seed, medium to small, weighing three-fourths ounce. The fruit has good keeping qualities.

GRAPES.

The past year was favorable for the production of grapes, and the locally-grown fruit appeared constantly on the markets. The station is attempting to supplement the Isabella variety, the leading grape of Hawaii, with eight other varieties which are known to possess desirable qualities. These will be grafted on Isabella rootstocks for immediate production and cross-pollinated in an effort to secure improved table grapes suitable to island conditions. A number of vines of the Isabella variety have already fruited lightly. The tropical species known as *Vitis tiliæfolia* (S. P. I. No. 44060), introduced last year from the Bureau of Plant Industry, United States Department of Agriculture, has made good growth and is thought to have a future in connection with Hawaiian grape growing. Muscadine grapes, popular in the Southern States, are other introductions which are likely to become established.

The vineyard has been kept well cultivated and given irrigation when necessary, and the vines have been supported on a trellis of the Munson type. Sprayings with arsenate of lead have kept the Japanese beetle (*Adoretus umbrosus*) under control.

STRAWBERRIES.

New varieties of strawberries are being tested, and the growing of this fruit under screen in the home garden is being encouraged. It is thought that by inclosing a small strawberry bed in a specially constructed frame built after the manner of a hotbed and covered with heavy galvanized screening No. 26 (eight meshes to the inch) choice fruits can be grown under high culture without danger of its being destroyed by the Japanese beetle (*Adoretus umbrosus*). At the station an experimental frame of redwood 6 feet wide, 32 feet long, and 18 inches deep has been set in the soil to a depth of about 9 inches. The screens have been tacked to sashlike frames 4 by 6 feet and made to fit into the top of the frame resting on cleats. These are kept over the plants only at night, as the Japanese beetle is strictly nocturnal in flight and feeding. Inside the frame the varieties "New Carolina," Brandywine, and Progressive have been set in rows 1 foot apart in a bed of clean fresh soil with which well decomposed barnyard manure has been incorporated. Where the fruit is of such soft and quick growth and so hidden in the foliage as is the strawberry, a poisonous spray can not be safely used, and it is thought that the method outlined above will enable one to grow enough choice strawberries in the garden for family use at a reasonable cost.

TOMATOES.

The experiments in tomato improvement, which have for their object the development of varieties resisting attacks of the melon fly (*Bactrocera cucurbitæ*) and the Mediterranean fruit fly (*Ceratitis capitata*) and bearing fruit of increased size and improved quality, were continued.

The cross secured by hybridizing Earliana with the small, native tomato resulted in the production of a large tomato having fixed characters. It has the shape and toughness of skin of the wild tomato and some of the size and quality of Earliana. Seedlings of nearly 200 other variety hybrids, obtained in the same way, are being developed in order that it may be learned if they will continue to be reproduced true from seed.

Of a large number of interesting hybrids raised during the year, 53 have been selected for determination as to their ability to transmit their desirable qualities.

The results of the experiment are proving satisfactory, yields in general being large, and only few of the variety hybrids being susceptible to fly attacks.

OTHER FRUITS.

Root cuttings of the seedless breadfruit (*Artocarpus inscisa*) were propagated from surface roots in the fall. Six-inch cuttings which were laid horizontally in coral sand several inches below the surface made the best growth.

In September, 1921, a fine collection of seeds of the longan (*Euphoria longana*) was received from the Department of Productive Industries, Formosa. Eighty healthy seedlings have been grown from this seed, although it was in a sprouting condition when it arrived.

One thrifty mangosteen tree (*Garcinia mangostana*), sent from the United States Department of Agriculture, is growing at the station. Twenty-four trees of this species were received from Java during the year, but all were dead on arrival. Efforts will be continued to establish this valuable species in the Territory.

Root cuttings of a number of varieties of fig (*Ficus carica*) have been distributed, and two new varieties, a small, yellow fruited sort, and the Kadota, a white fig from California, are being propagated.

Seeds of the Pejubaye palm (*Guilielma utilis*) from Central America have been placed in sand for germination. The flesh about the seeds is the edible portion and is said to be of high food value. It is hoped that this useful tree can be established in the islands.

Seedlings have been grown from a number of seeds of the tree tomato (*Cyphomandra betacea*) which were received in the autumn of 1921.

Strawberry guavas (*Psidium cattleianum*) of an improved strain are being grown in the station orchard, and many young trees are being propagated for distribution.

NUTS.

COCONUTS.

Although all the coconut trees in the Territory are of the species *Cocos nucifera*, they have fixed characters which are peculiar to the group of Pacific Islands whence it came. These characters reproduce even when the nuts are grown in Hawaii.

Tests of three materials were again made to determine the quickest and best way to secure germination of coconuts. Nuts were buried in rice hulls in the first test, in coarse black sand in the second test, and in coral beach sand in the third test, being placed in each case in pits 18 inches deep. Some nuts in each pit were buried whole, while others, from which a portion of the outer hull was removed at the base, were set with cut ends up just below the surface. Those set in rice hulls with cut ends up germinated best, sending up shoots in two and three months.

MACADAMIA.

Only a small crop of Macadamia nuts was obtained from the trees growing at the Tantalus substation. A number of these germinated, however, 50 young trees being set out at the substation and several hundred distributed throughout the Territory. The Macadamia will grow in the warmer localities near sea level, but it thrives better and makes more rapid growth in the cooler places.

PILI.

Several hundred Pili nuts (*Canarium ovatum*) were received from J. E. Higgins, of the College of Agriculture, Philippine Islands, during the year. Various tests were made to determine the best way to secure germination, but in each instance the percentage of germination was low.

PISTACHIO.

The pistachio is being propagated in the hope of getting it established in the Territory. Budding and grafting experiments will be undertaken as soon as the seedlings (*Pistacia vera* and *P. chinensis*) reach sufficient size. With the great variations of climate existing in the Hawaiian Islands it is thought that some locality can be found where this valuable nut will thrive.

REPORT OF THE AGRONOMY DIVISION.

By H. L. Chung.

ROOT CROPS.

CASSAVA.

Twenty-two varieties of cassava (*Manihot utilissima*) were grown in a light clay soil to determine their yielding values. The crop was harvested June 7, 1922, after a growing period of 15½ months. The four outstanding varieties for yield were São Pedro Preto, Tapicura, French No. 3, and Basioroa, which produced at the rate of 19.10, 13.23, 12.76, and 11.59 tons, respectively, per acre.

MANGEL WURZELS.

In December, 1921, a test of four varieties of mangel wurzels was undertaken to determine their yield when grown on a medium-clay

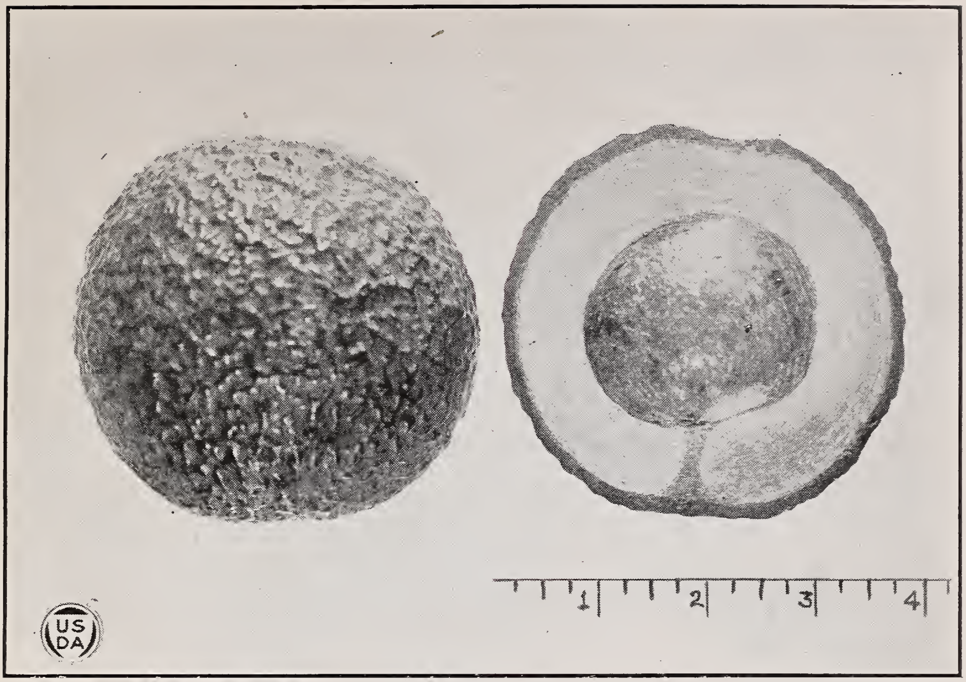

FIG. 1.—BEARDSLEE AVOCADO. HARD-SHELLED FRUIT OF EXCELLENT QUALITY.

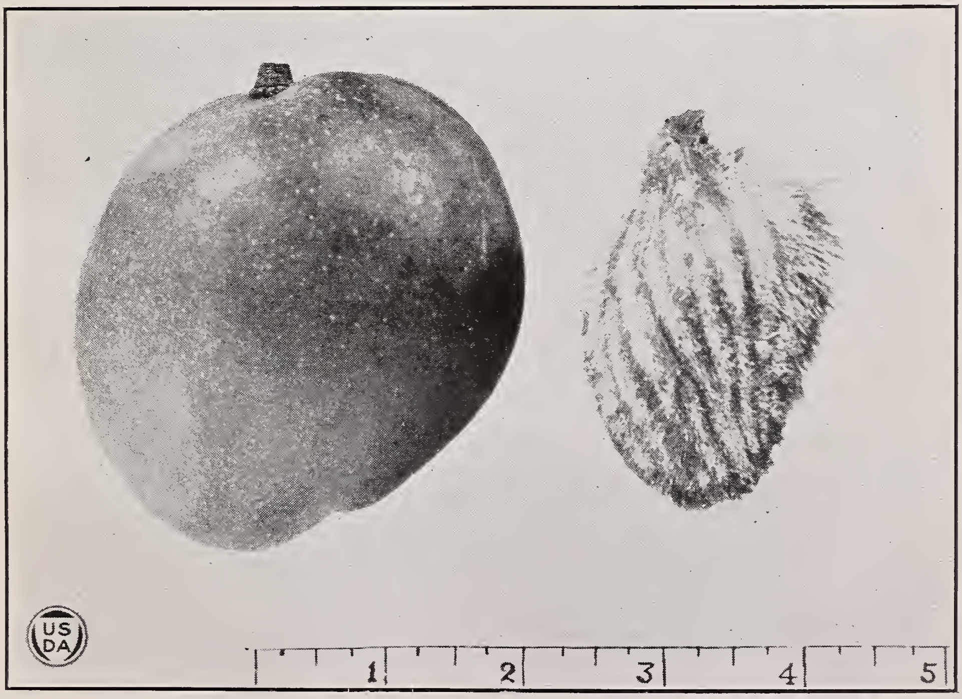

FIG. 2.—KALIHI MANGO. QUALITY EXCELLENT.

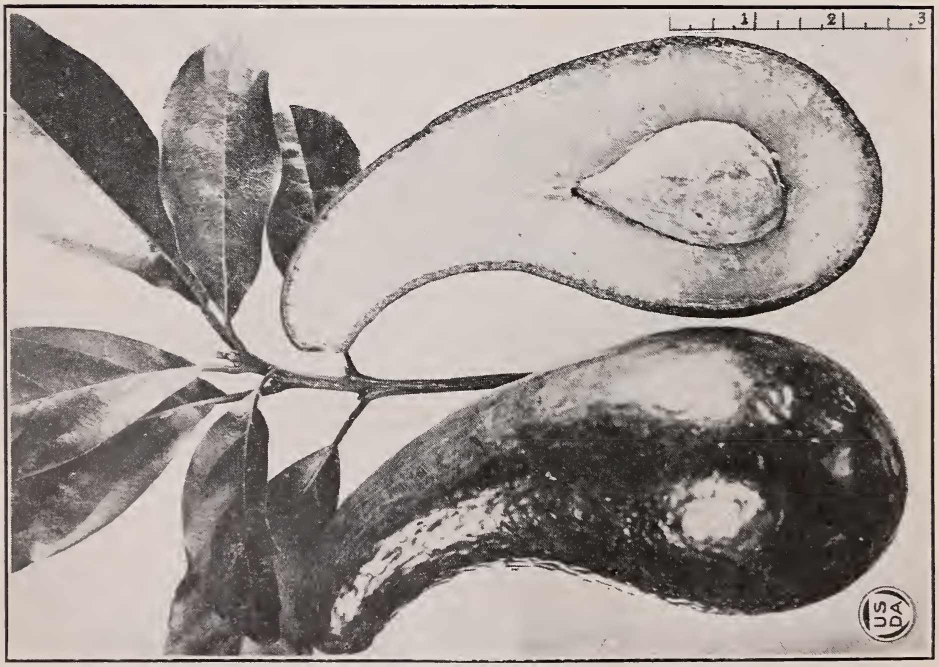

FIG. 1.—CASE AVOCADO.

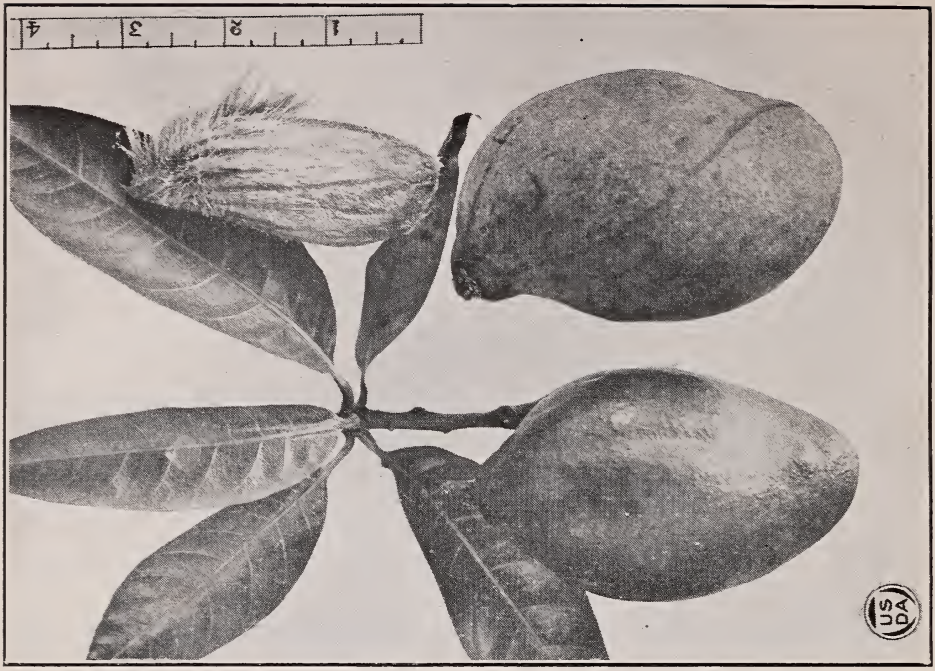

FIG. 2.—HAWAIIAN HYBRID MANGO (VICTORIA).

soil with infrequent irrigation. The crop was given only three light irrigations and two cultivations from the time of planting to the last harvest.

Mammoth Long Red and Champion Yellow Globe made the highest yields, producing 26.6 and 27.7 tons, respectively, of roots in 4 months and 11 days after planting. These varieties were not only heavy yielders, but they also made luxuriant growth and were fairly resistant to drought.

CORN.

Corn investigations were again confined to breeding and the stabilization of a yellow strain of Guam corn. Careful selection of ears conforming in every character except color to the original white variety has resulted in the production of a large number of well-shaped ears showing uniformity of color and type of kernel.

In a hybridization experiment, undertaken in conjunction with the sweet corn investigations, a hybrid white Guam corn was used as the mother and the Henderson Sweet as the staminate parent. The former was planted in alternate rows with the latter and was detasseled at tasseling time. The hybrid cornstalks, representing 75 per cent sweet and 25 per cent Guam stock, are making vigorous growth and the kernels are in the dough stage (June 30, 1922).

FORAGE CROPS.

GRASSES.

Large distributions of cuttings of Napier grass (*Pennisetum purpureum*) and Merker grass (*P. merkeri*) were again made during the year to dairymen and farmers, and approximately 1½ acres were planted with these grasses for the production of cuttings for immediate delivery.

In conjunction with the improvement of forage crops, plantings were made of individual seedlings of Merker grass, giving indications of quality, heavy stooling, and rank growth.

In a comparative test of Napier grass, sugar cane, and kafir corn, Merker grass made the highest yields, producing 47.95 tons of green forage in two cuttings. The yield of Napier grass in the second cutting undoubtedly would have been higher had not Uba cane been grown close to it on one side and Merker grass on the other. The following table gives the results of the test:

Yield of eight forage crops which were planted May 7, 1921.

Crop.	Yield per acre.	
	First cutting, Nov. 7, 1921.	Second cutting, Apr. 7, 1922.
	Tons.	*Tons.*
Yellow Caledonia sugar cane	10.54	13.02
Lahaina sugar cane	9.84	3.13
Merker grass	23.52	24.43
Napier grass	19.16	6.44
Uba sugar cane	23.17	23.82
D-1135 sugar cane	13.94	12.35
109 sugar cane	2.11	3.39
Kafir corn	7.92	11.02

Natal redtop (*Tricholæna rosea*), Australian blue (*Andropogon sericeus*), Australian water grass (*Paspalum dilatatum*), Wilder grass (*Andropogon* sp.), and fuzzy top (*A. saccharoides*), which were planted in the demonstration plats in July, 1915, yielded in two cuttings, 7.7, 8.58, 6.43, 4.32, and 6.16 tons, respectively, of green forage. The relatively low yields were due to abnormal growth resulting from continuous cropping through seven years and consequent root binding. Data obtained from this protracted experiment show that about four years is the period of greatest usefulness of these grasses for pasture purposes.

A nonirrigated test was made of Tunis grass (*Andropogon sorghum*), Sudan grass (*Andropogon* sp.), Wonder Forage (*Andropogon* sp.), and *Panicum antidotale* from July 30, 1921, to April 3, 1922. Yields were about one-third of what could presumably be obtained with irrigation.

Panicum setosum and *P. complanatum*, planted July 7, 1921, yielded on October 28 at the rate of 50.9 and 6.7 tons, respectively, of green forage per acre. *P. setosum* is a rank growing grass and attains a height of 3 feet under normal conditions.

Exophorus unisetus and Guatemala grass (*Tripsacum laxum*), two new grasses tested during the year, have been found to be valuable additions as feed for livestock. The former is an erect grass and attains a height of 2½ feet to 4 feet. Its stems and leaves are of excellent quality. At the station this grass produced at the rate of 44.6 tons of green forage per acre, and large quantities of the seed were distributed to those interested in the improvement of Hawaiian pasture grasses.

Guatemala grass (Pl. VII, fig. 1) was cut for the first time July 26, 1921, when it yielded at the rate of 46.5 tons of green forage per acre. In an experiment made to determine whether this grass could be grown by cuttings, it was found that 60 per cent of the cuttings took root and developed into vigorous plants, 10 per cent developed but died later, and 30 per cent failed to develop.

SORGHUMS.

Four varieties of grain sorghum were tested for their green forage value during the year. An African variety, No. 309, produced 6.68 tons in 4½ months, while kafir, Amber cane, and Egyptian corn yielded 6, 8.9, and 4.9 tons, respectively, of green forage in three months.

KALE.

Jersey and Giant Marrow were planted to obtain data as to their yield and adaptability to poultry rations. Of the two varieties, Giant Marrow made the heavier yield, exceeding Jersey by 5.8 tons in the first harvest, 10 in the second, 5.1 in the third, and 8.9 in the last.

Many large plants of the Giant Marrow variety succumbed to the attacks of the larvæ of the melon fly.

LEGUMINOUS CROPS.

COWPEAS.

During the year station hybrid No. 1383, planted primarily for the production of seed, yielded approximately 200 pounds of clean seed from three plantings. Individual plants that were observed to be outstanding in rankness of growth, heaviness of foliage, and prolificacy, were selected for future work.

HUBAM CLOVER.

Hubam clover, planted on one-tenth acre for forage and seed production, yielded at the rate of 12.4 tons per acre on one-twentieth acre for a growing period of three months. The rest of the plat produced 22.5 pounds of hulled seed, or at the rate of 450 pounds per acre.

SUNN HEMP.

Work with sunn hemp (*Crotalaria juncea*) was confined to the selection of plants producing heavy foliage and many pods in the hope of improving the variety in these two characters.

DISTRIBUTION OF SEEDS AND CUTTINGS.

The number of seeds and cuttings distributed by the agronomy division during the year slightly exceeded that of the preceding year. For the 12 months ending June 30, 1922, the distributions were made in amounts as follows:

Seeds and cuttings distributed during the year ending June 30, 1922.

Crop.	Seeds.	Cuttings.	Crop.	Seeds.	Cuttings.
	Pounds.	*Number.*		*Pounds.*	*Number.*
Napier grass	4	55,412	Edible canna "tubers"		12,504
Giant Bermuda grass		2,136	Cassava		2,416
Merker grass	4	2,822	Corn	195	
Natal redtop grass	8	24	Pigeon peas	109	
Sudan grass		26	Peanuts	37	
Java grass		12	Beans	30	
Kulthi grass		8	Mungo beans	32	
Kikuya grass		4	Kale	½	
Tunis grass		2	Alfalfa	8	
Australian blue grass	1		Hubam clover	6	
Wonder Forage	4		Cotton seeds	2	
Molasses grass	1		Kudzu (rooted cuttings)		130
Buffalo grass [1]		3,000	Sorghum	1	
Uba cane		8,700	Sunflowers	1	
Honohono		25	Field turnips	1	
Sweet potatoes		8,408	Egyptian corn	1	

[1] Hawaiian variety.

POULTRY.

Judging from the nature and number of inquiries received, it is thought that poultry raisers are coming to realize more and more that intelligent culling is a deciding factor in profitable poultry production. A number of articles published by the agronomist in one of the local newspapers have undoubtedly stimulated this phase of the work.

Early in July, 1921, the station, working in cooperation with the Union Feed Co. (Ltd.), sent the writer to the mainland to study the poultry industry in the Haywood and Petaluma districts, California, and at the Agricultural College and Hanson Poultry Farm, Oregon. Two hundred and thirty yearling White Leghorn hens and cockerels and 31 Barred Plymouth Rock hens were purchased and taken to Honolulu by the writer. The White Leghorn hens selected were bred for high-egg production, having first-year trapnest records ranging from 250 to 298 eggs. The cockerels were immediate descendants of hens having a trapnest record of 304 to 307 eggs for their first year. The Barred Plymouth Rocks, purchased for patrons of the feed company, were closely related to a hen which had laid 324 eggs in 365 consecutive days at the California farm bureau egg-laying contest in Santa Cruz. All of the fowls were examined for characteristics indicating heavy egg-laying capacity and to make certain that they were free from disease, and a study was made of each fowl's pedigree. Shortly after their arrival in Honolulu, the Leghorns were graded and placed in four separate pens according to their egg records.

The agronomist also assisted in establishing a poultry plant at the United States Marine Corps Barracks, Pearl Harbor.

Sorehead (*Epithelioma contagiosum*) was very prevalent in some of the poultry yards during the year and caused heavy losses on Oahu in spite of the precautions taken. (Pl. VIII, figs. 1 and 2.) During the coming year it is hoped that sufficient time can be found to permit of the study of this disease relative to its prevention and cure.

Coccidiosis, a common poultry disease, appeared in two flocks in a new form, and the poultry succumbed without warning. On postmortem examination the respiratory and digestive organs were found to be normal, except the cæca, which were distended and filled with coagulated blood. (Pl. VIII, fig. 3.) This disease was mentioned as an unidentified disease in last year's report.[1]

As soon as the disease is detected in the flock, crude catechu should be placed in the water given the birds to drink (one-third teaspoonful of the former to 1 gallon of the latter) for a period of one week, or until the birds regain their normal condition.[2]

REPORT OF THE CHEMICAL DIVISION.

By J. C. Ripperton.

COOPERATIVE FERTILIZER EXPERIMENTS.

BANANAS.

The great possibilities of banana growing on a commercial scale seem to warrant the undertaking of a series of rather intensive fertilizer experiments in connection with this crop. Tests are being made to determine the effect on the crop of applying fertilizers in single and fractional doses throughout the growing season, as well

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[1] Hawaii Sta. Rpt. 1921, p. 35.
[2] U. S. Dept. Agr. Farmers' Bul. 957, Important poultry diseases, p. 23, 24.

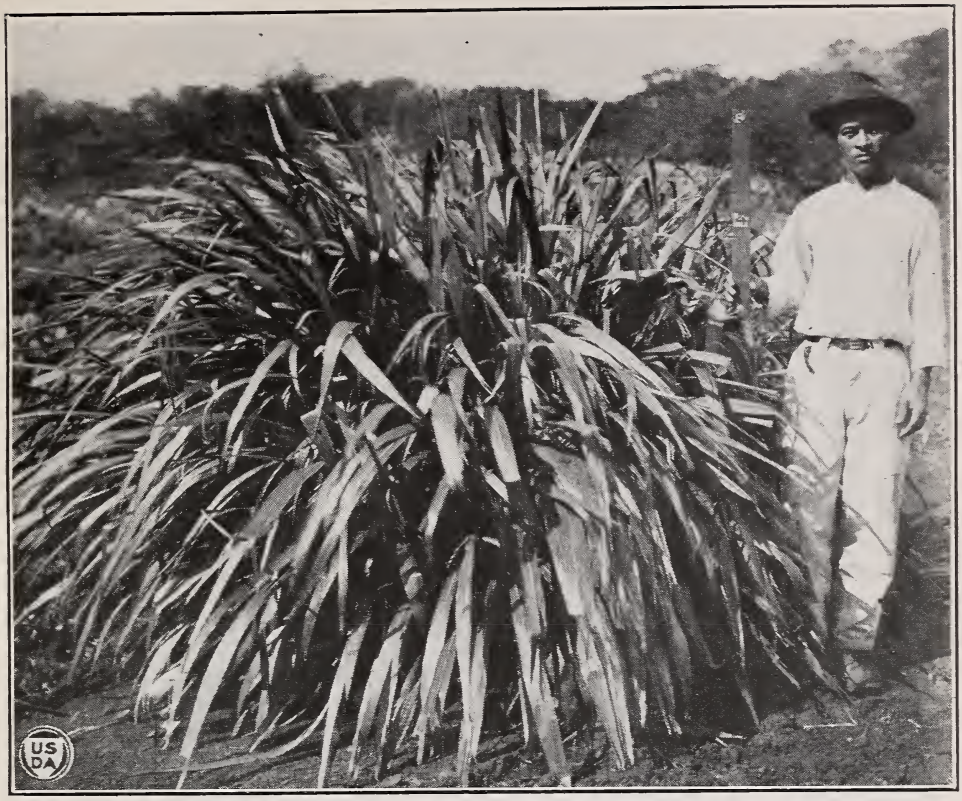

FIG. 1.—GUATEMALA GRASS (TRIPSACUM LAXUM).

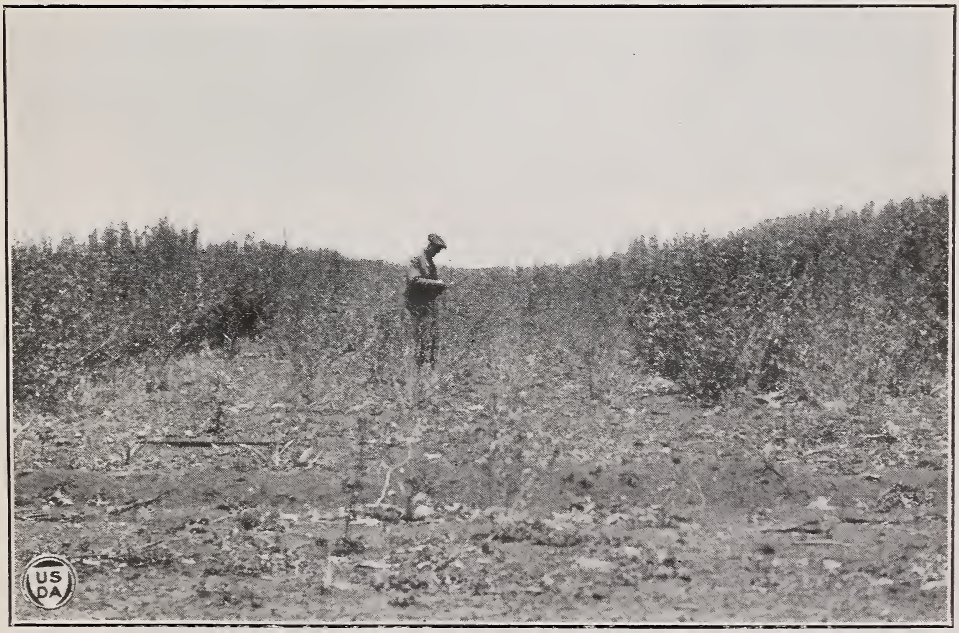

FIG. 2.—PIGEON PEAS. CENTER NOT FERTILIZED; BOTH SIDES RECEIVED FERTILIZER.

PLATE VIII.

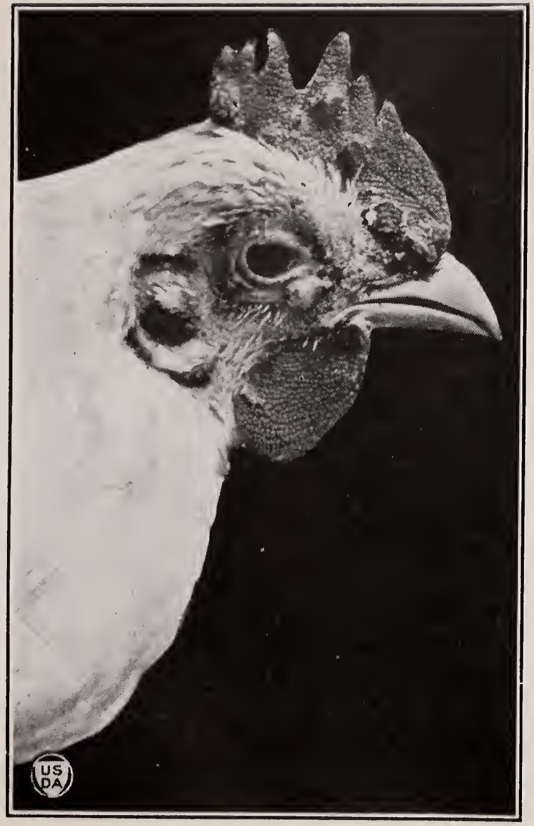

FIG. I.—SOREHEAD, MILD FORM.

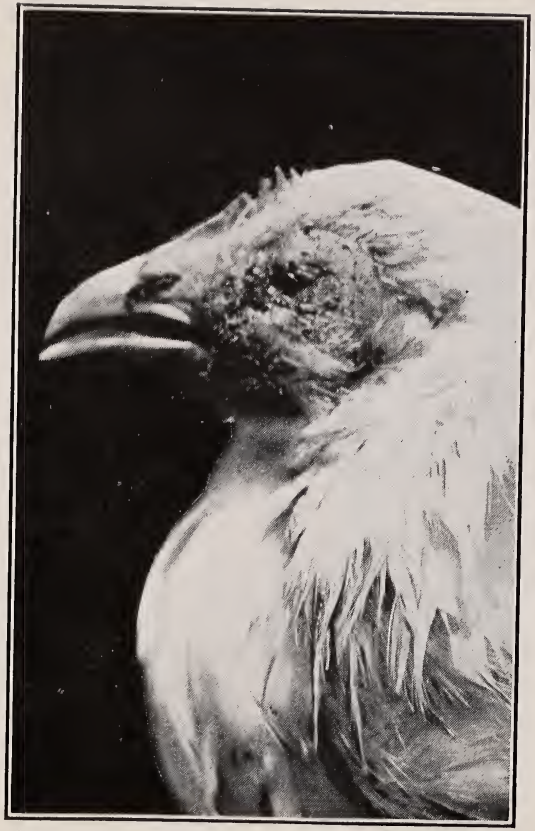

FIG. 2.—SOREHEAD, SEVERE.

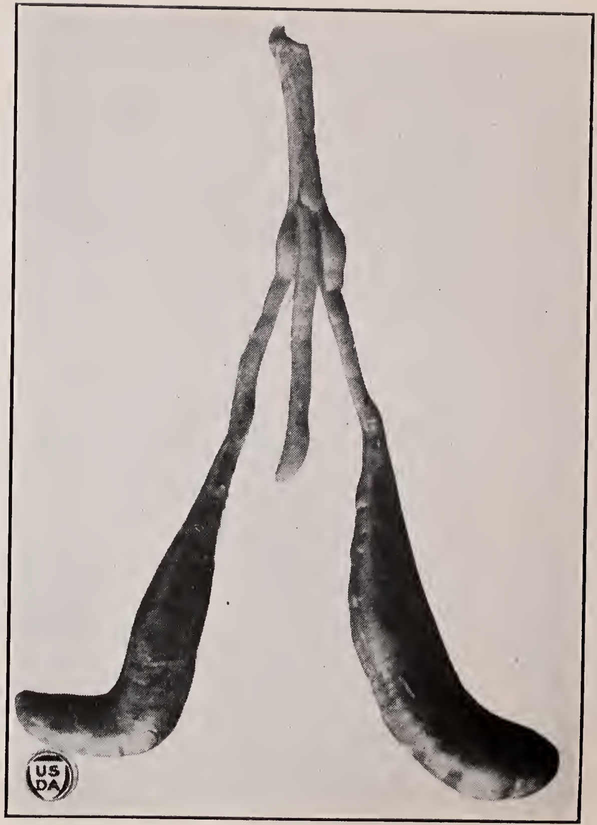

FIG. 3.—CÆCA OF PULLET DISTENDED WITH COAGULATED BLOOD, RESULT OF COCCIDIOSIS.

as the effect of leaching by irrigation waters on fertilizers applied in different parts of the ridge or furrow.

Three crops of bananas, harvested from the triangular fertilizer experiments,[3] failed to show any appreciable increase in weight or number of bunches due to fertilizer. Observation of the drainage ditches, opened to prevent water logging, showed a rapid downward percolation of the irrigation water, and the percolates were found to contain appreciable quantities of all the fertilizer salts applied.

Examination of the roots of a number of plants which were dug at different stages of maturity showed that the banana is essentially a surface feeder. Root hairs were found only on the upper whorl of roots except in case of plants two months of age or less. Some of the more vigorous plants had two whorls of feeding roots, but the lower roots were in a dormant or half-decayed condition. In Hawaii, where the banana is planted in a trench about 2 feet deep and the feeding roots extend outward almost horizontally into the ridges in consequence, it would seem that the fertilizer should be applied close to the surface.

In December, 1921, six half-acre plats were laid off and planted to bananas to determine the best method of applying fertilizer to the crop. In the first plat the total quantity of fertilizer was hoed in around the base of the plants immediately before irrigation; in the second plat a small trench was dug around the plants and the total quantity of fertilizer was hoed in the sides of the ridge and at about the level of the water during irrigation, so that capillary water only would reach the fertilizer; in the third plat one-sixth of the total quantity is being applied each month about the base of the plants and hoed in immediately before irrigation; and in the fourth plat one-sixth of the total quantity is being applied each month about the base of the plants immediately after the irrigation water sinks below the surface of the trench. The two remaining plats are serving as checks.

The same kind and quantity of fertilizer is being used in each plat. The fertilizer is made up chiefly of water-soluble salts, with nitrogen, phosphoric acid, and potash in the proportions of 6, 12, and 7 per cent, respectively, and it is being applied at the rate of 1,500 pounds per acre, which is equivalent to 1.5 pounds per plant.

Drainage ditches have been cut to permit of a comparison of the seepage water from the different plats, and it is expected that a series of percolation experiments will be carried on for the purpose of comparing the quantities of fertilizer leached out under the different methods of application.

PINEAPPLES.

In 1919 ten 0.1-acre plats at the New Era homestead farm were planted with 800 pineapple shoots each to determine the effect of fertilizer on pineapple wilt. The first application was made two weeks after planting, and the second, a supplementary one consisting of one-fourth the original quantity, was made on half of each fertilized plat one year later. Fertilizer was found to exert little or no effect on the crop, the last harvesting cycle of which was completed in August, 1922. The field was infested with pineapple wilt before the plant crop was harvested, and plats Nos. 1 and 2 were so severely damaged that less than half the plants produced matured fruit. The following table gives the yield of the plats as a whole:

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[3] Hawaii Sta. Rpt. 1920, p. 34.

Yield and weight of pineapple plant crop, grown with and without fertilizer, at Haiku.

Plat No.	Fertilizer treatment per plat.			Number of fruits harvested per plat.	Total weight of fruits per plat.	Average weight per fruit.
	Nitrogen mixture.[1]	Acid phosphate.	Potassium phosphate.			
	Pounds.	*Pounds.*	*Pounds.*		*Pounds.*	*Pounds.*
1	75			279	1, 260	4. 51
2	50	31		301	1, 457	4. 84
2 (check) [2]				455	2, 361	5. 18
3	50		8. 3	527	2, 699	5. 12
4	25	58. 3		484	2, 536	5. 24
4 (check)[2]				533	2, 846	5. 34
5	25	31	8. 3	546	2, 804	5. 13
6	25		16. 6	608	3, 147	5. 17
6 (check) [2]				632	3, 245	5. 13
7		87. 5		554	3, 034	5. 47
8		62	8. 3	524	2, 842	5. 42
8 (check)[2]				530	2, 665	5. 02
9		31	16. 6	537	2, 898	5. 39
10			25	514	2, 875	5. 59

[1] Ammonium sulphate, 45 per cent, and sodium nitrate, 55 per cent.

[2] No fertilizer.

In considering the results it should be borne in mind that the field became severely infected with pineapple wilt, and, as is shown by the high average weight of the fruit produced on the check plats, the soil was exceptionally fertile and would not therefore respond to fertilizer treatment as would poorer soil. The experiment shows that neither the fertilizers used nor the vigorous growth made by the crop was able to ward off the wilt. The experiment was discontinued with the final harvest.

UPLAND SUGAR CANE.

In order to determine the effect of fertilizer on yield, Yellow Caledonia upland sugar cane was planted October, 1919, at Haiku on 26 plats, each one-tenth of an acre in size, which had previously been cropped with pineapples. Nonirrigated sugar cane, which has the same cycle of productive growth as the pineapple and yields as high as 6 tons of sugar per acre, gives promise as a profitable crop for rotating with pineapples in certain sections. Three rows were made to a plat. The first fertilizer was applied October 15, 1919, and about a month later two rows of each fertilized plat were given a supplementary application equaling one-fourth the quantity applied the first time. The year following planting was exceptionally dry and the cane made very little growth. The second year, however, had normal rainfall and the growth was rapid, but harvesting was delayed until the spring of 1922. Since the crop showed no effect of the supplementary application, only the yield of the plats as a whole are given in the following table:

Yield of upland sugar cane at Haiku.

Plat No.	Fertilizer treatment per plat.			Yield per plat.		Calculated increase per acre, due to fertilizers.	
	Nitrogen mixture.[1]	Acid phosphate.	Potassium sulphate.	Cane.	Sugar.	Cane.	Sugar.
	Pounds.	*Pounds.*	*Pounds.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
1[2]	75			2.27	0.289	4.50	0.573
2	60	20		2.75	.350	.30	.038
3 (check)[3]				2.72	.346		
4	60		5	2.81	.358	.86	.110
5	45	40		3.19	.407	4.62	.589
6	45	20		3.11	.396	3.78	.482
7	45		10	3.17	.404	4.34	.553
8 (check)[3]				2.74	.349		
9	30	60		3.01	.384	3.58	.456
10	30	40	5	2.84	.362	2.76	.352
11	30	20	10	3.01	.384	5.34	.680
12	30		15	2.74	.349	3.52	.448
13 (check)[3]				2.30	.293		
14	15	80		2.78	.354	3.98	.507
15	15	60	5	2.84	.362	3.76	.479
16	15	40	10	2.74	.349	1.94	.247
17	15	20	15	2.90	.369	2.72	.345
18 (check)[3]				2.71	.345		
19	15		20	3.08	.393	3.68	.469
20		100		3.05	.389	3.36	.428
21		80	5	3.44	.438	7.24	.922
22		60	10	3.33	.425	6.12	.780
23 (check)[3]				2.72	.346		
24		40	15	2.97	.378	2.50	.318
25		20	20	3.02	.385	3.00	.382
26			25	2.76	.352	.40	.051

[1] Ammonium sulphate, 45 per cent, and sodium nitrate, 55 per cent.

[2] Damaged by cattle.

[3] No fertilizer.

The above table shows that distinct increases resulted from the fertilizer treatment, but there appears to be no relation between the amount of increase and the composition of the fertilizer applied. Phosphoric acid was the only single fertilizer giving an appreciable increase, and plats 21 and 22, which received this element in fairly large quantities, made the highest yields.

FERTILITY-ROTATION EXPERIMENT.

During the year the pigeon-pea crop was plowed under and both the pineapple and sugar cane plant crops were harvested. The unusually severe drought of 1919–20 caused these two crops to make small yields, and very little effect could be attributed to the fertilizer treatments. The pineapple plat receiving nitrogen mixture (sodium nitrate, 55 per cent, and ammonium sulphate, 45 per cent) at the rate of 400 pounds per acre was very perceptibly greener and sturdier than the adjacent plats. The fruit averaged one-half pound heavier than that from the check plat. The plat receiving nitrogen mixture and potassium sulphate at the rate of 400 and 200 pounds, respectively, per acre responded equally well. This experiment will be continued.

PRESERVATION OF HAWAIIAN FRUITS.

During the year an intensive study was made of the guava, grape, and roselle for the purpose of developing a systematic procedure for making jelly from any kind of tropical fruit containing pectin and acid. The results of this investigation have been submitted for publication.[4] Cooperative work with a local company with a view to standardizing the juices used for jelly making was continued, and the methods developed in the foregoing study are proving practicable for jelly making on a commercial scale.

Additional products having especial commercial possibilities are dehydrated mango, from which an excellent candied fruit can be made; dehydrated papaya, which mixed with lemon makes a cheap but excellent jam; and dehydrated guava, from which jelly can be made.

MINERAL CONSTITUENTS OF HAWAIIAN VEGETABLES.

Certain classes of people in Hawaii are of the opinion that locally grown vegetables are lacking in lime, iron, and other essential mineral constituents, and that they are not, for that reason, as good as the imported vegetables. Results of an experiment, conducted to determine the mineral constituents of the more common locally grown vegetables, show that Hawaiian-grown vegetables are as high in mineral content as the imported. The following table gives the results of a preliminary test made to determine the mineral constituents of spinach and cabbage, which are commonly found on the markets of the mainland, as compared with those of the locally grown cabbage and Chinese spinach:

Comparison of mineral constituents of Hawaiian and mainland grown spinach and cabbage.

[Calculated as percentages of dry material.]

Vegetable.	Where grown.	Total ash.	Phosphoric acid (P_2O_5).	Ferric oxid (Fe_2O_3)	Potash (K_2O).	Lime (CaO).
Spinach (canned)	California	20.82	0.97	0.048	3.92	0.90
Spinach (dehydrated)	Oregon	22.16	1.90	.075	7.65	.82
Spinach (fresh)	Hawaii (Honolulu)	23.36	1.97	.102	7.11	2.85
Do	do	17.60				2.92
Do	do	21.34				2.82
Do.[1]	Virginia	20.68	1.33	.090	8.60	1.14
Cabbage (fresh)[2]	Ohio	7.19	.59		3.01	.83
Do	Hawaii (Oahu)	9.13	.98	.045	3.20	.93

[1] Jour. Agr. Research, v. 16, No. 1, p. 17.

[2] Ohio Agr. Expt. Sta. Bul. 255, p. 226.

Some of the variations in results may be due to lack of uniformity in the variety of vegetable tested, and in the case of the California sample loss of some of the mineral constituents may have occurred during the process of canning. The results show, however, that locally grown spinach and cabbage are equal, if not superior, to the commonly imported brands in the important mineral constituents.

Carrots, beets, cabbages, spinach, string beans, and peas have been planted in two widely separate localities on the mainland (Virginia and Washington State), and also in two localities on Oahu in order that a comparison may be made of their nutritive constitutents. All four series are to be harvested at the same stage of maturity and then dried. Any difference in composition of each crop will doubtless be due to the soil and climatic conditions prevailing at each place, since the seed stock is the same.

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[4] Hawaii Sta. Bul. 47, Application of the principles of jelly making to Hawaiian fruits.

HAWAIIAN STARCHES.

TREE FERN.

Three experimental plats have been established at different altitudes along the Volcano Road to determine the feasibility of replanting the tree fern for starch production on cut-over areas. At the end of 9 months 85 per cent of the plantings were growing, including crowns, and large and small lateral shoots of the several varieties.

Rate of growth of the tree fern has been learned by measuring the vertical distance between the frond pits on the same "spiral." A complete circle of fronds averaging five in number develops at one time and each frond of the circle represents one of the spirals on the trunk. Since probably only one circle of fronds is developed in a year, it is concluded that the annual vertical growth is about 4 inches.

EDIBLE CANNA.

Complete chemical analyses are being made each month of samples of edible canna to determine at what stage of growth the tubers will yield the maximum amount of starch, and an experiment is being conducted in cooperation with a company in Hilo to study the commercial possibilities of the crop. In June, 1922, edible canna was planted in 36 plats, each one-tenth acre in size, to determine its fertilizer requirements. The plats are 18 miles from Hilo along the Volcano Road, where the elevation is 2,000 feet, and the soil is somewhat thin, being underlain by undecomposed lava at a depth of a few inches to several feet. The first application of fertilizer will be made in July, 1922, and the results of the experiment reported upon next year.

Small plats of canna have been planted along the Volcano Road at elevations varying from 300 to 3,500 feet to learn the highest altitude in which the crop can be successfully raised. Monthly harvests are to be made of 10 hills on each plat to ascertain the rate of growth and maximum yield.

EFFECT ON CROPS OF BRACKISH IRRIGATION WATER.

Studies are being continued to determine the tolerance of various crops to brackish irrigation water. Three crops, alfalfa, rice, and Napier grass were planted in lysimeters, and after germinating and reaching a height of 2 inches in fresh water were given measured quantities of water containing varying amounts of sodium chlorid. The percolates were collected and the sodium determined. Alfalfa was found to withstand a greater percentage of salt when once well established than when it was in the seedling stage.

Many soils which have been watered continuously with salty irrigation water are showing evidence of considerable accumulation of salt. It is planned to repeat the above-mentioned experiment with a second crop to learn what this cumulative effect in the soil is. It is also planned to visit all the important irrigated sections of the islands to learn the salt content of the well water used in each district, the salt accumulation in the soil, and the kind and condition of crops being grown. The results should furnish a valuable guide for each district as to the limit of salt in the water, the danger of its accumulation, and the salt tolerance of all the common crops.

REPORT OF EXTENSION AND DEMONSTRATION WORK ON THE ISLAND OF HAWAII.

By R. A. Goff.

SOILING CROPS FOR PLANTATIONS.

The majority of the plantation owners, having enlarged their dairies or established new ones for the purpose of providing their laborers with milk at cost, are interested in the question of feeds for dairy stock. Pigeon peas and Napier grass are apparently the two crops best adapted to this purpose, as they produce a number of ratoon crops before it is necessary to replant, withstand the heavy rains and occasional dry periods of the district equally well, and form a balanced ration with the addition of very little imported milled feeds. Distribution of seeds and cuttings of these crops has been made to various plantations, and every assistance has been given to those who are interested in planting.

SCHOOL AND HOME GARDEN WORK.

The extension agent acted as one of the judges in the Star-Bulletin school-garden contest in the districts of Kau, Kona, Waiamea, and Kohala, and in the smaller contests in the outlying districts of Hamakua and Puna. Three visits were made to each of 11 schools and 35 home gardens, the pupils accompanying the judges in each instance to the gardens to discuss insect pests, seed varieties, and fertilizers.

COOPERATION WITH BOY SCOUTS.

The extension agent has served as scout commissioner for the island since January, 1922. He has given a number of talks on natural history and gardening to the scouts at schools in the country and has taken the boys on hikes to various plantations and homesteads to instruct them in the use of farming implements.

WORK IN WAIAMEA DISTRICT.

In 1922, A. W. Carter, manager of the Parker ranch, set aside 16 acres as a demonstration plat for the raising of crops of benefit either to the ranch or to local homesteaders. The work is carried on under the direction of the extension agent, and the labor, farming implements, and work animals are furnished by the ranch. Over 50 varieties of seed were supplied by H. L. Chung, of the central station, and as many more were ordered from the States, Australia, and England by Mr. Carter. Most of the plantings have been failures so far, due to the elevation (2,700 feet) and to the prevailing heavy winds of the district. Corn (three varieties), potatoes (two varieties), forage crops (eight varieties), beets (four varieties), grasses (seven varieties), and clover (two varieties) are apparently doing well, however. Many homesteaders are interested in the project and are making inquiries about the different varieties being tried.

WORK IN KOHALA DISTRICT.

Through the efforts of the extension agent, many seedling trees were obtained from the local nursery of the Board of Agriculture and Forestry for planting as windbreaks in the district of Kohala. Fruit trees were pruned, plantings distributed, and talks given to groups of interested homesteaders who have considerable area in pineapples.

WORK IN KONA AND KAU DISTRICTS.

During the year the extension agent ordered seed of brome and rye grasses, pigeon peas, and bur and sweet clover, which have done well elsewhere on Hawaii, for the owners of cattle ranches in the districts of Kona and Kau, where they are being tried for the first time. The crops have been planted in plats and broadcasted in pastures and should help to improve the land.

A dairy is planned in connection with the junior high school at Kealekekua, Kona, and purebred Holstein cattle have been promised by the Parker ranch when an additional 10 acres, adjoining the school property, is secured and the buildings are up. Seeds and cuttings of Peruvian and Grimm alfalfa, Napier grass, Waiamea white corn, Boone County White and Reid's Yellow Dent corn, pigeon peas, and *Paspalum dilatatum* have already been planted so as to provide some of the necessary feed for the cattle when they arrive. The boys of the school are raising the crops. Two ranchers of the district have already asked for seed of some of the crops which they have seen growing at the school.

GLENWOOD SUBSTATION AND DEMONSTRATION FARM.

The number of livestock is being rapidly increased in the Glenwood district, and animal raising is being depended upon for profitable returns owing to the difficulty of raising marketable crops. Forage crops which can be fed green are being grown, and Australian water grass and bur clover are being broadcasted to improve the pastures rapidly.

The dairy herd of the substation consists of 14 milk cows and 20 heifers and calves, which will be headed by a recently purchased purebred Holstein bull calf. In addition to this herd there are on hand 1 purebred Berkshire boar, 3 Berkshire sows, and a poultry flock, which is increasing at the rate of 100 laying hens a year.

The farm was established for the purpose of demonstrating that 50 acres of well-stocked land in the Glenwood district can be made to support a family. It has done good work, and in the opinion of X. L. Helbush, the collaborator in immediate charge, the projects should be brought to a satisfactory close during the coming year.

FRUIT TREE NURSERY.

In 1921, 2,000 avocado and 500 mango seedlings were planted for the purpose of budding and grafting some of the better varieties of these trees for free distribution. With the assistance of C. E. Vaile, agriculturist at the Hilo Boarding School, 650 of the avocado seedlings were budded with wood from winter bearing trees in Hilo, and about 400 more are being budded with material sent from the central station. The remaining avocado and all of the mango seedlings will be worked over this summer as they become of sufficient size. Papaya seedlings have been distributed and some 800 rough lemon and shaddock seed planted for stock for grapefruit and orange budding.

REPORT OF HOME DEMONSTRATION ACTIVITIES.

By Mrs. N. A. Russell.

During the summer and autumn of 1921 the home economics demonstrator, acting in cooperation with the social welfare bureau, made weekly visits to one of the local pineapple canneries, where she instructed groups of 22 to 75 Japanese, Chinese, Philippine, Portuguese, and Hawaiian women in the growing and use of fruits and vegetables. At least one practical recipe was worked out for each fruit or vegetable, and samples of the prepared dishes were given to those attending.

In cooperation with the housewives' league, she gave an hour's talk each month, followed by demonstrations, on the utilization of meats, vegetables, and fruits of the Hawaiian Islands. This group of women is largely of American parentage, and as many as 100 attended some of the meetings.

Demonstrations of the making of papaya and tomato products were given in cooperation with the educational committee of Wahiawa for the benefit of the boys and girls of the seventh and eighth grades. Fully 48 children and 7 adults attended each meeting.

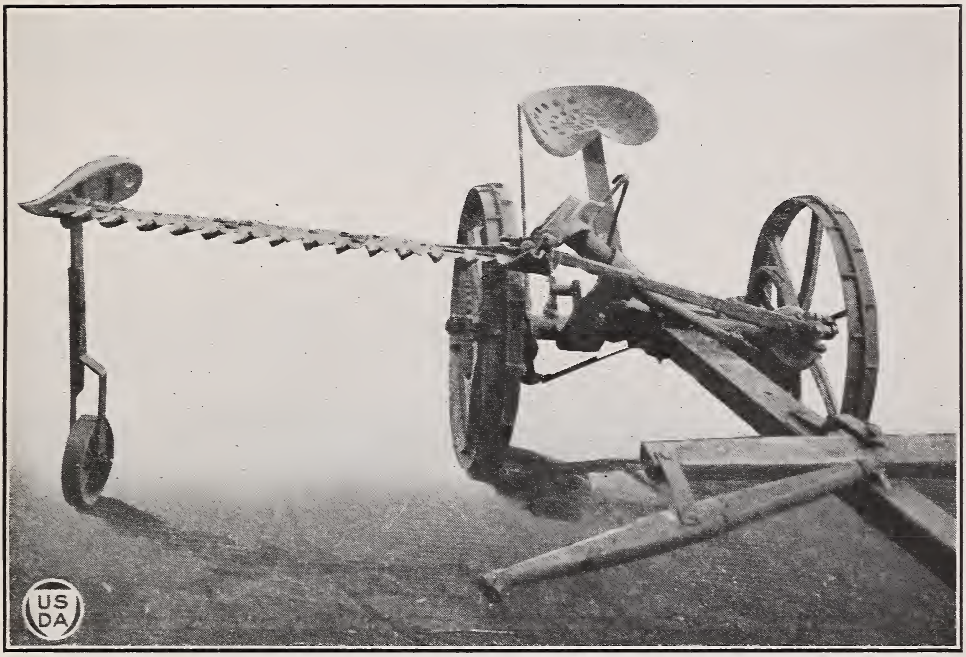
HAIKU SUBSTATION AND DEMONSTRATION FARM.

By F. G. Krauss.

PIGEON PEAS.

Probably no other crop in Hawaii lends itself so readily to a large variety of conditions as does the pigeon pea. Fully 10,000 acres are under cultivation in Hawaii, and fully 25 tons of the seed, or enough to plant 5,000 acres, was distributed during the year, large quantities being sent to Guam, Australia, New Zealand, East Africa, California, and Florida. The adaptability of the crop to very sandy and somewhat saline beach lands has been fully demonstrated.

Under average field conditions pigeon peas as pasturage may be expected to carry from one to two and one-half head of cattle per



MOWER ADAPTED FOR CUTTING PIGEON PEA FORAGE.

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acre for two 100-day periods, or during the normal seeding stage of the crop. An acre of pigeon peas under good average conditions should produce from 300 to 1,000 pounds of prime beef per annum. The same lands in ordinary grass pasture frequently carry less than one head for 2½ to 5 acres.

The following table gives the relative yield per acre of ordinary field crops of pigeon peas with and without irrigation:

Comparative yields per acre of pigeon peas, grown with and without irrigation.

[Seven months after planting.]

Parts of individual plant.	Nonirrigated field.	Irrigated field.
	Pounds.	*Pounds.*
Whole plant (including roots)	32, 500	82, 900
Forage	11, 400	30, 560
Seed (shelled)	1, 120	1, 623

These data were compiled from results obtained by a sugar company in Maui and from the University Farm, Manoa Valley, Oahu. The Maui soil is very sandy and somewhat saline. The Oahu soil is a heavy, gravelly loam. Both soils are extremely dry in summer and produce very few crops without irrigation. The above table shows that under the conditions noted greatly increased crop yields may be expected from irrigation.

PIGEON-PEA FERTILIZER EXPERIMENT.

In a fertilizer experiment, conducted at Pupukea on raw uplands failing to produce more than 2 or 3 tons of pineapples per acre and only very few other crops, a fertilized plat yielded 13.07 tons of green forage, compared with 2.61 tons produced by an unfertilized plat. (Pl. VII, fig. 2.) The results show that under the unusual conditions presented in this case fertilization is essential and profitable for the production of even moderate yields. Phosphatic fertilizer was applied at the rate of 500 pounds per acre in the drill at the time of planting at a cost of about $12 per acre.

IMPROVED EQUIPMENT FOR THE CROP.

Judging by the new and improved machinery now being devised by various pigeon-pea growers, it would seem that a well-designed pigeon-pea equipment should be available for use within the year. Through the ingenuity of E. Falk, farm superintendent for Dr. W. D. Baldwin, Haiku, Maui, an ordinary mowing machine has been adapted to cut pigeon-pea forage. (Pl. IX.) The cutting bar of the mower is elevated to cut at a height of about 30 inches, the tongue or pole being moved to the center of the frame, the forepart of which is lifted at the same time to the desired height. This is done automatically by placing the pole under instead of over the frame. The pole is held firmly in place by a strong supplementary iron clamp. A seeder having fertilizer attachment has been devised by L. E. Arnold to facilitate the work of planting large areas of pigeon peas.

PINEAPPLES.

Pineapple growers are giving every attention to improved cultural methods and to careful breeding work through bud selection. Far better tillage is being practiced than formerly, and green manuring crops are being plowed under with excellent results over widely different conditions. It is thought that pineapples can be made to follow sugar cane satisfactorily. At Haiku a 5-acre field in which pineapples are following cassava is doing well.

Substantial advances are being made in the use of commercial chemical fertilizers, 500 to 1,000 pounds of which are being applied in the drill at the time of planting, followed by supplementary doses of ammonium sulphate throughout the growth of the crop. These later applications may be applied as a spray or top or side dressing. Spraying with iron-sulphate solutions with or without ammonium sulphate has become a common practice on manganiferous soils. Possibly one of the most radical and far-reaching practices inaugurated in connection with pineapple culture in recent years is the introduction of the paper mulch. It is as yet too early to predict its final outcome.

HALEAKALA SUBSTATION AND DEMONSTRATION FARM.

By J. F. O'Brien.[5]

MISCELLANEOUS PLANTINGS.

During the year about 30 different crops were tested either in small plats under different quantities of fertilizer or under field conditions. Ten acres each of cowpeas and soy beans and 1 acre each of 10 different varieties of corn were planted for trial. The low night temperature at this elevation (1,800 feet) is not conducive to the best production of corn, and the crop was forced to grow with less than 2 inches of rainfall a month. The most successful field crops are those thriving during the cool rainy season from September to March and ripening during the hot, dry season of June and July.

The pigeon pea has proved its adaptability to conditions at the Haleakala demonstration farm, and its seed has assisted materially in furnishing feed for turkeys.

Seed of the purple vetch, inoculated and planted November 12 on a freshly cleared plat, made excellent growth, yielding 10 tons of green forage per acre within 100 days after planting. The second growth was nearly as heavy as the first and required about 200 days in which to mature its seed.

Emmer, planted in December, 1921, survived the severe rain and wind storm that practically destroyed oats and other crops. It began heading 120 days after planting. Some acclimatization work will have to be done with this crop, but its showing in comparison with other grain crops is such as to make it take rank with the promising crops of the locality.

The Bellingham pea made excellent growth under field conditions, even though only lightly fertilized with equal parts of reverted and superphosphate. The crop matures in about 120 days. Plantings made in January gave the best results. By planting early in October and again in January, however, it is possible to obtain two crops from the same land within 12 months. These peas will not thrive in warm weather. They should be planted fairly thick, either broadcast or in rows from 2 to 3½ feet apart, and be kept well cultivated.

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[5] Temporarily employed as collaborator.

HALEAKALA TOMATO.

The Haleakala tomato, which has been especially selected and bred for its fly-resistant qualities, has for a number of years shown itself adapted to conditions on Maui. It shows a tendency to produce its fruit in clusters, bearing five and six rather large fruits at almost the same height on the stem.

MISCELLANEOUS FRUITS.

Carolina strawberries, planted October, 1921, made excellent growth, the berries being large and plentiful. In ordinary seasons planting should be made in September immediately after the heavy rains. The ground should be pulverized as deeply as possible, and enriched with stable manure (20 tons per acre). The plants should be kept cultivated.

It is thought that the wild variety of poha can be made to grow under cultivation with a corresponding increase in yield.

LIVESTOCK.

The station is maintaining a small herd of goats headed by a registered Toggenburg buck, Gretel's Son No. 1554. The entire local area is typical grazing land, and there is every indication that dairying can be successfully carried on. It is also felt that poultry and hog production may be made supplemental lines of work to other activities helping to make successful a number of self-supporting small farms in the vicinity.

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